11. Professor Bennett sketched briefly some of the reasons which have led to the introduction of imaginary points into geometry. He then showed that for some purposes a "complex" point, where the coördinates are complex numbers of algebra, is not the only convenient generalization beyond the set of real points of space. Another generalization involving a special class of square matrices with quaternionic elements satisfies the usual vectorial requirements, and may be used to define a "space" in which the notion of distance continues to have its characteristic properties. The "real" points of such a space constitute an ordinary real space, so that one may interpret familiar geometric loci as having not only real points but further points in such a generalized space.

O. S. ADAMS, *Secretary-Treasurer.*

THE JUNE MEETING OF THE MINNESOTA SECTION.

The regular meeting of the Minnesota Section was held at the College of Saint Thomas, St. Paul, Minn., on Saturday, June 4. The attendance was twenty-one, including the following thirteen members of the Association:

R. M. Barton, W. O. Beal, W. H. Bussey, H. H. Dalaker, Gladys Gibbens, W. L. Hart, Dunham Jackson, R. A. Johnson, Arvid Reuterdahl, Minna Schick, F. J. Taylor, Ella Thorp, Vera L. Wright.

Dinner was served at six o'clock with the College of Saint Thomas as host. At a business meeting which followed the following officers were elected: Chairman, Professor REUTERDAHL; Secretary-treasurer, Professor BARTON; Members of the executive committee, Professor DALAKER, Miss GIBBENS, Professor C. H. GINGRICH. The report of the Secretary-treasurer was approved as presented.

The following papers were presented:

(1) "Mathematical induction" by Professor W. H. BUSSEY, University of Minnesota.

(2) "Constructions with ruler and circular disk" by Professor R. A. JOHNSON, Hamline University.

(3) "Some problems in medicine which the mathematician must solve" by Dr. R. E. SCAMMON, University of Minnesota (by invitation).

Abstracts of the papers follow below, the numbers corresponding to the numbers in the list of titles.

1. Ordinary mathematical induction may be described briefly as an argument from n to $n + 1$. Professor Bussey's note called attention to some generalizations of ordinary mathematical induction of which the most simple may be described as an argument from n and $n + 1$ together to $n + 2$.

2. Professor Johnson discussed the somewhat well-known proposition that all constructions which can be effected with ruler and compasses are possible with a ruler and a circular disk whose center is not given.

3. Dr. Scammon indicated how the applications of mathematics to the problems of the medical sciences may be divided roughly in two classes. Of

these the first are the applications which come through extension of the mathematical solutions of problems in physics and chemistry to similar problems in biology. Examples of this class are the application of the mathematical laws of hydrodynamics to problems of hæmodynamics, of mathematical optics to problems of physiologic optics, and of the various mathematical expressions for stress and strain to problems of muscle and bone mechanics. This phase of the application of mathematics is of long standing in medicine, having developed in the latter part of the seventeenth century. The second class of applications arose primarily through the attempt to reduce the highly variable data of medicine to some form of graphic or numerical expression. This is a more recent development since the collection of precise medical data (other than experimental records and vital statistics) practically began with the work of Louis in the early part of the nineteenth century. The mathematical treatment of this data was first attempted by Gavarret and Quetelet a little later. The modern development of this phase has proceeded mainly along the lines laid down by Galton and Karl Pearson. Among the problems in this field at the present time are the application of the mathematical principles of variation and correlation to a large and varied mass of biologic data, and the development of suitable methods of curve fitting, coördinate analysis and establishment of empirical formulæ for this type of material.

R. M. Barton, *Secretary-Treasurer.*

GRAPHICAL SOLUTIONS OF THE QUADRATIC, CUBIC, AND BIQUADRATIC EQUATIONS.

By T. R. RUNNING, University of Michigan.

Graphical solutions of equations may in general be divided into two classes. One class consists of geometrical constructions for each particular equation. The constructions depend upon the numerical values of the coefficients. Any such construction which will give the roots of an equation with a given set of coefficients must be changed for any equation having a different set of coefficients. The other class consists of charts or diagrams from which the roots are read when the coefficients or combinations of them are used as coördinates.

In what follows the solutions are given by means of charts. Such charts are made up of straight lines and curves from which the roots (both real and imaginary) are read approximately.

There are many such graphical solutions for the real roots of the simpler algebraic equations, but, so far as the writer is aware, the imaginary roots are obtained only by geometric constructions for each particular equation.[1] Such

[1] A few references are as follows:

Klein, *Vorträge über ausgewählte Fragen der Elementargeometrie*, 1895, pp. 28–31; in Beman and Smith's translation, p. 34.

d'Ocagne, *Traité de Nomographie*, 1899.